

The use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries

Citation for published version (APA):

Nour, S. (2011). *The use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries*. UNU-MERIT, Maastricht Economic and Social Research and Training Centre on Innovation and Technology. UNU-MERIT Working Papers No. 059

Document status and date:

Published: 01/01/2011

Document Version:

Publisher's PDF, also known as Version of record

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy

If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.



Working Paper Series

#2011-059

The use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries

By Samia Satti Osman Mohamed Nour

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)

email: info@merit.unu.edu | website: <http://www.merit.unu.edu>

Maastricht Graduate School of Governance (MGSoG)

email: info-governance@maastrichtuniversity.nl | website: <http://mgsog.merit.unu.edu>

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

UNU-MERIT Working Papers

ISSN 1871-9872

**Maastricht Economic and social Research Institute on Innovation and Technology,
UNU-MERIT**

**Maastricht Graduate School of Governance
MGSoG**

*UNU-MERIT Working Papers intend to disseminate preliminary results of research
carried out at UNU-MERIT and MGSoG to stimulate discussion on the issues raised.*

**The Use and Economic Impacts of ICT at the Macro-Micro levels in
the Arab Gulf Countries**

By Dr Samia Satti Osman Mohamed Nour

(October 10, 2010)

The Use and Economic Impacts of ICT at the Macro-Micro levels in the Arab Gulf Countries

By Dr Samia Satti Osman Mohamed Nour

(October 10, 2010)¹

Abstract

In this paper we use some primary micro data from the firm survey of Nour (2002b) and some secondary cross countries data to examine the use and economic impacts of ICT at both the macro-micro levels in the Arab Gulf countries. We find that at the macro and micro levels the demand for ICT (measured by the use and spending on ICT) is characterised by considerable dynamism over time, i.e. shows a dynamic increasing trend across countries, but an opposite decreasing trend across firms. At the macro level the use/demand for ICT increases with income (measured by GDP per capita) and decreases with price. At the micro level, total spending on ICT increases with firm size (capital and labour) and industry level. At the micro level, we find positive correlations between the total spending on ICT, output and profit. At the macro level, spending on ICT as percentage to GDP shows a positive significant correlation with GDP- as an indicator of economic growth - and a positive insignificant correlation with schooling. Therefore, the total spending on ICT shows positive but somewhat inconclusive economic impacts at both micro and macro levels in the Gulf countries.

Keywords: Use of ICT, ICT market, ICT impacts, Gulf countries.

JEL classification: O3, O30

¹ Corresponding Author: Dr. Samia Satti Osman Mohamed Nour, Visiting Research Fellow, University of Maastricht, School of Business and Economics, UNU-MERIT, Maastricht, The Netherlands; and Assistant Professor of Economics, Economics Department, Faculty of Economic and Social Studies, Khartoum University, Khartoum, Sudan. E-mail: samiasatti@yahoo.com; samia_satti@hotmail.com. This paper is a revised version of the paper originally prepared during the author's time as a Ph.D. fellow at Maastricht University and UNU-INTECH, now UNU-MERIT, Maastricht, The Netherlands from September 1999 to November 2005. The author gratefully acknowledges UNU-INTECH for research grant and fellowship. The second draft of this paper was revised and presented at the GLOBELICS Academy (2008): Ph.D. School on National Systems of Innovation and Economic Development, GLOBELICS Academy 2008, organized jointly by the Global Network for the Economics of Learning, Innovation, and Competence Building Systems (GLOBELICS) and the Unit for Science, Technology and Innovation Studies (TaSTI), University of Tampere, Tampere, Finland, and held at the Unit for Science, Technology and Innovation Studies (TaSTI), University of Tampere, Tampere, Finland, June 2-13, 2008. The author would like to thank Professor Théophile Azomahou and the participants for their useful comments on the first draft of the paper. All the usual disclaimers apply.

The Use and Economic Impacts of ICT at the Macro-Micro levels in the Arab Gulf Countries

Introduction

In the recent years the diffusion of information and communication technologies (ICT) and the influences they create on economic systems increased rapidly in both the developed and developing countries. In this paper we examine the use and economic impacts of ICT at the macro-micro levels mainly in the Arab Gulf countries. Our paper is organised as follows: Section 1 presents an introduction and briefly shows the theoretical and empirical literature on the effect of ICT and the relationship between ICT and economic growth as confirmed in the endogenous growth literature. Next we examine the first and second stylised facts on the status, nature, trend and determinants of the use and demand for ICT at the macro-micro levels in the Arab Gulf countries in Section 2. Section 3 discusses the third and fourth stylised facts on the economic impacts of the use of ICT at both macro and micro levels in these countries, finally Section 4 concludes.

1. Theoretical and empirical literature on the relationship between ICT and economic growth

Both the rapid development in ICT and the recent trend of globalisation and their various influences in different economic systems have been exciting and interesting recent research issues that have received increasing interest amongst economists in both developed and developing countries. While it is admitted that the impacts of ICT, like many other forms of technological progress is difficult to measure, many recent theoretical and empirical literature use several indicators to approximate their effects in economic growth. For instance, some recent studies use an index of investment or expenditures on ICT, IT, computer or computer equipment and provide robust results showing the various influences on economic growth, productivity, employment, work organisation and skill upgrading. Several studies in the literature examine the positive impacts of ICT mainly IT on productivity (cf. Hitt and Brynjolfsson, 1996; Brynjolfsson and Yang, 1996), growth and development (cf. Jorgenson and Stiroh, 1995, Phojoia; 2000, 2001), work place organisation (cf. Bresnahan, Hitt and Brynjolfsson, 1999) and skill upgrading (cf. Hwang, 2000). One interesting finding in the literature emphasises the importance of ICT for enhancing economic growth not only directly, but also indirectly through the complementary relationships between ICT, human capital/skill and skill upgrading. For instance, several studies use many indicators to examine the complementary relationships between technological progress as measured by ICT and human capital, as measured by the increasing utilisation of higher educated workers (cf. Goldin and

Katz, 1998; Bresnahan et al., 1999; Autor, Katz and Krueger, 1998; Acemoglu, 1998). In conjunction with these interpretations, some studies explain the relationship between ICT, IT or computer use and skill upgrading defined by the increase either in the incidence of training (cf. Bresnahan, 1999) or the share of high skilled workers (cf. Autor, Katz and Krueger, 1998; Bresnahan, 1999; Hwang, 2000). On the other hand, along with the interpretation of the skill-biased nature of technical change, some studies investigate some negative impacts of the increasing use of IT or ICT (cf. Bound and Johnson, 1992; Berman Bound and Griliches, 1994; Freeman and Soete, 1994; Acemoglu, 1998; Autor, Katz and Krueger, 1998). Moreover, some studies have raised the controversy that the increasing use of ICT may have some negative impacts for developing countries, particularly, because of intensifying competition and creating more comparative advantages for developed countries and hence widening the already existing gap and digital divide between the developed and developing countries.

In light of the above background and given the relatively few studies (cf. Nour, 2006) that explain only limited aspects of ICT market in the Arab countries, it may be useful in this paper to examine both the use and economic impacts of ICT mainly in the Arab Gulf countries. In this paper we will be focusing only in the Arab Gulf countries that are more relevant, mainly because of the heavy concentration of ICT market in these countries and therefore the corresponding economic impacts are expected to be more important than the other Arab countries. Our study therefore may be interesting to contribute to recent effort aimed at building the information and knowledge society in the region and it will fill an important gap in the literature dealing with Arab countries. Our analysis in this paper is important, interesting and differs from earlier studies, since we present a comparative macro-micro analysis to examine the ICT market in these countries. In addition, we use the most up-to-date and relevant data wherever available. One limitation of our analysis in this paper is related to the limited scope of our analysis, since we explain only the economic impacts and the use/demand side of ICT market in the Arab countries. While we admit that it is also essential to investigate the supply side of ICT market in these countries, our analysis will not cover the supply side, mainly due to the scarcity of necessary information, which may be related to the somewhat monopolistic structure of the supply side as can be seen from the limited number of Internet Service Providers (ISP) in most of the Gulf countries (except Saudi Arabia); we leave that for more in-depth analysis in the future. Another limitation of our analysis is related to scarcity of an updated information at the macro level and the limited numbers of observations for some variables used in our analysis at the micro level that constitute some limitations of our regression results. Apart from these limitations, our paper is useful to improve understanding of ICT market and the corresponding economic impacts in the Arab region.

Our paper aims to examine both the use/demand and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries; in particular, our aim is to test the following four stylised facts:

1. At the macro and micro levels, the demand for ICT (measured by the use and spending on ICT) is characterised by considerable dynamism: it shows a dynamic increasing trend over time across countries but a decreasing trend over time across firms.
2. At the macro level the use/demand for ICT shows a normal demand curve decreasing in price and increasing in income (measured by GDP per capita). At the micro level, spending on ICT increases in firm size (capital and labour) and industry level.
3. At the macro level, the use of Internet and mobile shows positive significant correlations (complementary relationships) with the use of telephone. At the micro level, the use of/total spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training.
4. At the macro and micro levels spending on ICT show positive but inconclusive economic impact.

To examine the four stylised facts presented above, we use the descriptive approach and OLS technique. Our analysis at the micro level uses primary data based on the results obtained from the survey of Nour (2002b) that covers the medium and large size firms, which are active in the chemical and metal industries in the United Arab Emirates as a case of the Gulf countries. Our analysis at the macro level uses the secondary data presented in Table 1 below.

Table 1- The use and economic impacts of ICT in the Arab Gulf countries (2000–2003)

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
Internet ^a	247	106	66	115	62	337
Telephone ^a	263	204	84	289	144	314
Mobile ^a	583	519	171	438	217	696
(\$ per 20 hours of use) ^a	39	25	24	22	35	13
(% of monthly GNI per capita) ^a	4	2	4	1	5	1
(per three minutes) ^a	2	2	1	2	2	2
GDP PC ^a	15196	14455	11813	19844	11377	22420
GDP PC ^b	17170	16240	13340	19844	12650	22420
GDP ^a	7594046	27000650	15601980	NA	165504500	56380000
GDP ^b	7.7	35.4	20.3	17.5	188.5	71
ICT/GDP ^c	2	2.73	NA	NA	7.6	1.77
School life expectancy ^d	13	8.7	8.7	13.1	9.5	10.7
Mean years of Schooling year ^e	6.1	6.2	0.9	5.8	3.9	5.6

Sources: (a) World Development Indicators database and International Telecommunication Union, (b) UNDP (2004), (c) ESCWA (2003), (d) UNESCO-UIS database (2005), (e) Barro and Lee database (2000), (f) WITSA (2002).

2.1 The status of ICT in the Arab Gulf countries

Earlier studies have explained that the Arab countries are still falling far behind the advanced world countries and the international level in terms of both the use and spending on ICT (cf. Nour, 2002a, 2006). More recent information from the Information Telecommunication Union (ITU) indicates that the growth rate of main telephone lines falls below the world average, however, the growth rate of cellular subscribers increased faster than the world average throughout the period 1996-2003. Within the Arab region, we observe the substantial disparity in terms of ICT diffusion across the Arab high, medium and low income groups. In particular, the Internet users, telephone mainlines and cellular subscribers are mainly concentrated in the Arab high income Gulf countries. For instance, in 2002 the average share of high, medium and low income respectively accounted for: 81%, 17% and 2% of total Internet users; 68%, 27% and 5% of total access to telephone mainlines; and 78%, 16% and 6% of total cellular subscribers in the Arab countries. Table 2 below indicates that despite the fact that the population in the Gulf countries accounts only for 11% of total Arab population, due to high GDP per capita they dominate the ICT market in the Arab region; the Gulf population accounts for 70%, 55% and 71% of the total Arab population using the Internet, telephone and mobile. In this paper, our analysis in the next sections will focus only on the Arab Gulf countries, mainly because the anticipated corresponding economic impacts are likely to be more important than the other Arab countries due to the heavy concentration of ICT market in these countries. Table 3 below illustrates that in terms of both ICT use index and personal computer (PC) purchasing power over the period 2002-03, the average for the Gulf countries is higher than the average for all Arab countries.²

² The ICT use index covers four ICT parameters: PC installed base and the number of Internet users, mobile phones and fixed lines. The index is calculated by adding up the values of these four parameters and dividing the sum by the country's population figure. A higher index score indicate more aggressive ICT adoption in the country under question. Higher PC purchasing power may reflect more aggressive attitude toward PC purchase.

Table 2- Demand for and Supply of ICT: total Population, percentage of total population with access to main Telephone lines, Mobile Cellular, Internet and Internet Services Providers (ISP) in the Arab Gulf Countries (2002)

Country	Total Population (Million) (2002)	GDP/per capita (PPP US \$) (2002)	Internet services providers	Population accessing Internet (share in Arab)	Population accessing Telephone (share in Arab)	Population accessing Mobile (share in Arab)
	2002	2002	2002	2002	2002	2002
United Arab Emirates	2.9 (1)	22,420	1	313.2 (24)	291 (12)	647 (18)
Qatar	0.6 (0.2)	19,844	1	113.4 (9)	286 (12)	433 (12)
Kuwait	2.4 (0.8)	16,240	3	105.8 (8)	204 (9)	519 (14)
Bahrain	0.7 (0.2)	17,170	1	245 (19)	261 (11)	579 (16)
Oman	2.8 (0.9)	13,340	NA	70.0 (5)	92 (4)	183 (5)
Saudi Arabia	23.5 (7.9)	12,650	21	64.6 (5)	151 (6)	228 (6)
Average [total] Gulf	[32.9] (11.1)	16,944	[27]	(70)	(55)	(71)
Average [total] Arab states	[296.6]	5,069		28.0	81	85
Norway				502.6	734	844
Sweden				5731	736	889
United States				551.4	646	906
United Kingdoms				423.1	591	814
Korea, South				551.9	489	679
Singapore				504.4	463	796

Source: UNDP (2004) Human Development Report (2004).

Table 3- ICT use index and PC purchasing power in Arab Gulf countries 2002- 2003

	End of 2002 IC use Index	End of 2003 IC use Index	PC units purchasable by GDP per capita
Bahrain	1.15	1.26	11.39
Kuwait	0.95	1.17	15.13
Qatar	0.75	0.92	23.05
Oman	0.35	0.39	6.66
Saudi Arabia	0.50	0.61	7.90
UAE	1.40	1.50	18.19
Average Gulf	0.85	0.975	3.03
Total Arab	0.22	0.27	2.27

Source: Madar Research Group: www.madarresearch.com

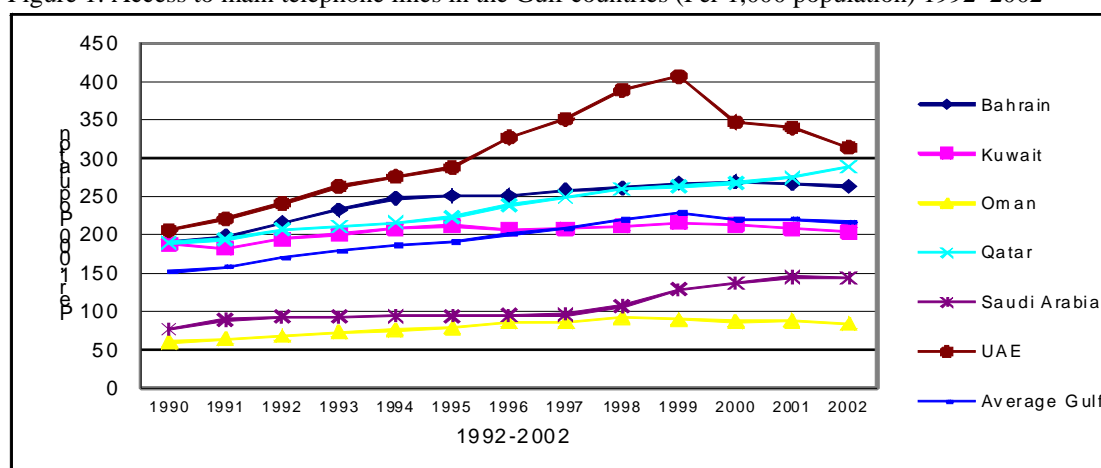
2.2 The trends and determinants of the use and demand for ICT at the macro-micro levels

Based on the above backgrounds, in this section it is useful to focus our analysis on the Arab Gulf countries. We first investigate the first stylised fact that at the macro and micro levels, the demand for ICT (measured by the use and spending on ICT) is characterised by considerable dynamism, i.e. it shows a dynamic increasing trend over time across countries but a decreasing trend over time across firms. For instance, Figures 1-3 below corroborate the first stylised fact that the use of telephone, mobile and Internet show a considerable dynamism with increasing trends over time at the macro level across the Gulf countries during the period 1992-2002. In contrast to the macro level, at the micro level Figure 4 below shows a dynamic but a considerable tremendous decreasing trend over time (over the period 1999-

2001) in total spending on ICT across firms - except a small increase within metal firms. This micro result can be attributed to a lack of plans for critical expansion on ICT or general contraction in total spending on ICT across firms.

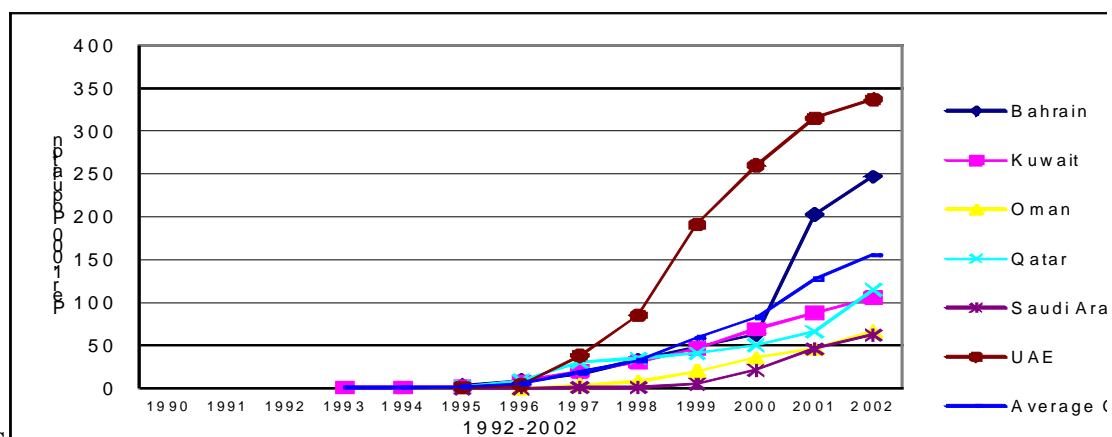
During the period 1999-2001 the uses of ICT (61%) increased faster than that of other technologies (56%) across all respondent firms in the firm survey conducted by Nour (2002b) (cf. Figure 5). At the micro level, the heavy concentration and large share in total ICT spending across the chemical and large size compared to metal and medium size firms indicates a considerable disparity in the use of ICT across firms- cf. Figure 6. This result implies considerable disparity across firms in terms of the total spending and the use of ICT according to firm size and industry level 1999-2001, i.e. large size and chemical firms tend to spend more on ICT compared to medium size and metal firms over the period. The share of large size firm exceeds 90%, while the share of medium size firms remains less than 10% of total ICT spending over the period 1999-2001. Similarly, the share of chemical firms ranges widely between more than 90% to near 60% while the share of metal firms ranges widely between less than 10% to near 40% of total ICT spending over the period 1999-2001.

Figure 1: Access to main telephone lines in the Gulf countries (Per 1,000 population) 1992–2002



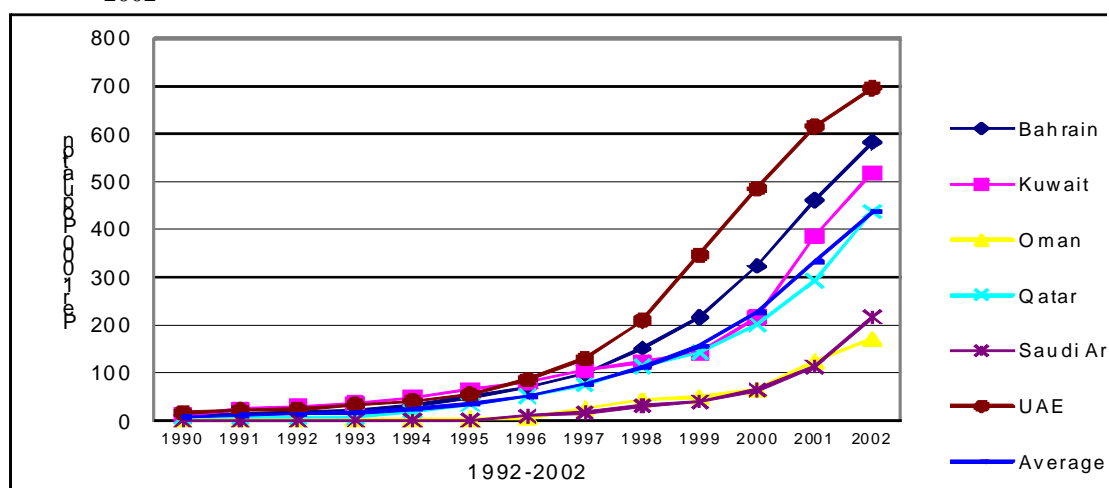
Sources: World Development Indicators database and International Telecommunication Union

Figure 2- The use of Internet in the Gulf countries (Per 1,000 population) 1992–2002



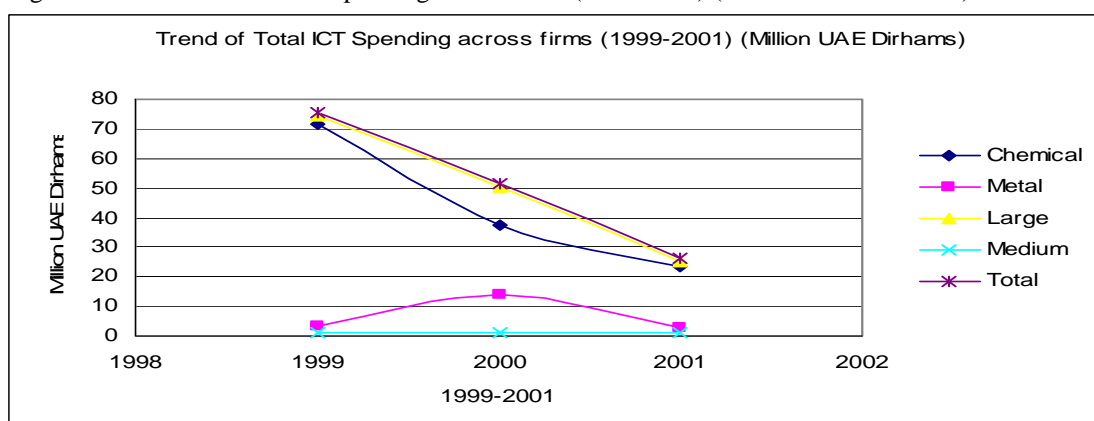
Sources: World Development Indicators database and International Telecommunication Union

Figure 3- The use of mobile cellular telephones in the Gulf countries (Per 1,000 population) 1992–2002



Sources: World Development Indicators database and International Telecommunication Union

Figure 4 –Trend of Total ICT Spending across firms (1999-2001) (Million UAE Dirhams)



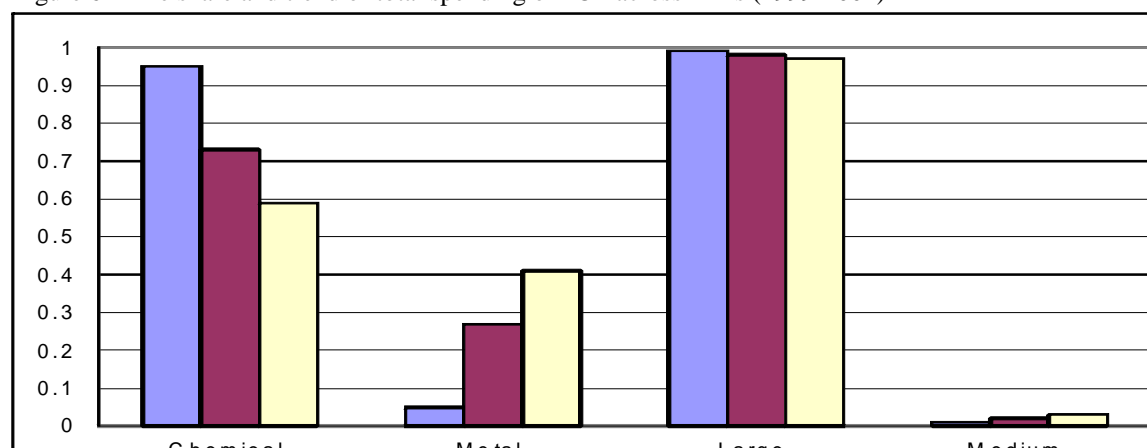
Source: Survey of Nour (2002b)

Figure 5- The increasing use of technology and ICT across firms, 1999-2001



Source: Survey of Nour (2002b)

Figure 6 – The share and trend of total spending on ICT across firms (1999-2001)



Source: Survey of Nour (2002b)

Our results in Tables 4-5 below prove the second stylised fact concerning the determinants of the use/demand for ICT that at the macro level the use of/demand for ICT shows a normal demand curve decreasing in price and increasing in income (measured by GDP per capita). At the micro level, spending on ICT increases with firm size (capital and labour) and industry level. Table 4 illustrates that at the macro level the use of/demand for ICT shows a normal demand curve decreasing in price and increasing in income (measured by GDP per capita). Mainly the use of Internet seems more sensitive and highly correlated with income level but less sensitive and negatively correlated to price at the macro level. Similarly, the use of telephone and mobile are highly sensitive and positively correlated to income (measured by GDP per capita). The correlation with GDP per capita is more significant with respect to telephone and mobile respectively than Internet. This result may imply that consumer preference – corresponding to purchasing power, income or GDP per capita - seems to be in favour of or more sensitive towards the use of telephone and mobile than the Internet, which may not be surprising in light of a considerable illiterate population, since the use of Internet requires more and specific literacy.³ So the majority – including those illiterate - of consumers/population may prefer to use telephone and mobile than Internet. Somewhat surprising is that the use of telephone is positively correlated to price. An inverse relationship between the demand and price of telephone may imply that even with the increasing price, the use of telephone will not diminish, i.e. telephone service is a necessary service for consumers in these countries. Table 5 below shows that at the micro level, total spending on ICT across firms is determined by/increases in firm size (capital and labour) and industry level (see also Figure 6 above).

³ The average illiteracy rate for the Gulf population (15 years and above) is 18.6%, cf. UNDP-HDR (2002).

Table 4- Determinants of ICT use: demand, price, GDP per capita across the Gulf countries 2002-03

across the Gulf countries at the macro level	Coefficient (t-value)					R ²
	Constant	Internet: (Price HRS)	Internet: (Price MTH)	Telephone: (Price MNTS)	GDPPC	R ²
Internet (All Gulf)	252.662 (1.614)	-3.690 (0.653)				0.096
Internet ((All Gulf)	235.247 (2.491)		-28.146 (-0.966)			0.186
Internet (All Gulf)	-243.240 (-1.550)				2.593** (2.593)	0.627
Telephone (All Gulf)	-74.800 (-0.531)			158.800** (2.110)		0.527
Telephone (All Gulf)	-157.437 (-2.033)				0.022** (4.923)	0.858
Mobile (All Gulf)	-357.200 (-1.421)				0.047** (3.224)	0.722

**. Correlation is significant at the 0.01 level (1-tailed)

Table 5- Total spending on ICT, labour and capital across firms 1999-2001

Independent variables		Labour	Capital	Constant	R ²	N
Dependent variable (ICT expenditures)		Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
ICT expenditures	Large	1.523** (4.625)		4.008 (2.138)	0.641	14
	Medium	9.418** (3.307)		-29.257 (-2.454)	0.610	9
	Chemical	2.065** (3.361)		1.179 (0.370)	0.485	14
	Metal	1.167** (2.674)		5.655 (2.537)	0.505	9
ICT expenditures (All firms) (log) ¹	1999	0.860** (2.636)	0.241* (1.651)	3.805 (1.805)	0.630	13
	2000	1.068** (2.461)	0.189 (0.978)	3.763 (1.290)	0.517	13
	2001	0.739** (2.243)	0.175 (1.264)	5.491 (2.573)	0.541	12

*. Correlation is significant at the 0.05 level (1-tailed), **. Correlation is significant at the 0.01 level (1- tailed). Note (1) Log value for all estimated variables: ICT, labour and capital

3. The economic impact of ICT at the macro-micro levels

Considering the above discussion on the use and determinant of ICT, in this section we examine the third and fourth stylised facts on the economic impacts of ICT at the macro-micro levels. Table 6 below substantiates the third stylised fact that at the macro level, the use of Internet and mobile shows positive significant correlations (complementary relationships) with the use of telephone. Our results summarised in Table 7 below corroborate the third stylised fact at the micro/firm level concerning the complementary relationships between the use of/spending on computer, telecommunication and training which can be read as complementarity between technology and upskilling (cf. Colecchia and Papaconstantinou, 1996; Bresnahan and Hitt, 1999). Muysken and Nour (2006) find complementary relationships between skill, technology (ICT) and upskilling (ICT training). For instance, from these results we observe the complementary relationship between the share of high

education and the share of expenditure on ICT, which can be seen and understood as complementarity between skill and technology (cf. Goldin and Katz, 1998; Acemoglu, 1998). We find a complementary relationship between the share of high education and the share of expenditure on ICT training, which can be interpreted as complementarity between skill and upskilling (cf. Muysken and Nour, 2006: 969).

Table 6- The complementary relationship between the use of Internet, telephone and mobile at the macro level and the impacts of ICT: ICT/GDP on GDP and schooling across the Gulf countries 2002-03

Internet and Telephone	Coefficient (t-value)					R ²
	Constant	Internet	Telephone	Mobile	ICT/GDP	R ²
Internet (All Gulf)	-52.036 (-0.564)		0.959** (2.403)			0.591
Telephone (All Gulf)	120.590 (2.531)	0.616** (2.403)				0.591
Mobile (All Gulf)	-8.978 (-0.073)		2.063** (3.903)			0.792
Telephone (All Gulf)	48.394 (1.033)			0.384** (3.903)		0.792
GDP (All Gulf)	-18.323 (-0.538)				26.659** (3.331)	0.847
Schooling (Gulf excluding SA)	4.869 (5.619)				0.507 (1.290)	0.635

**. Correlation is significant at the 0.01 level (1-tailed)

Table 7- The relationship between Computer, training and Telecommunication expenditure

Independent variables		Computer expenditure	Training expenditure	Telecommunication expenditure	Constant	R ²	N
Dependent variables (All firms)		Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
Computer expenditure: All firms	1999		0.620** (2.489)	0.198 (0.626)	2.484 (1.097)	0.815	10
	2000		0.487 (1.325)	0.431 (1.007)	0.633 (0.220)	0.677	12
	2001		0.847* (1.627)	-0.0564 (-0.125)	2.178 (1.141)	0.670	14
Training expenditure: All firms	1999	0.820** (2.489)		0.343 (0.985)	-2.544 (0.957)	0.830	10
	2000	0.369 (1.325)		0.639* (1.972)	-0.936 (-0.376)	0.755	12
	2001	0.247* (1.627)		0.661** (5.219)	0.546 (0.504)	0.911	14
Telecommunication expenditure: all firms	1999	0.309 (0.626)	0.405 (0.515)		3.720 (1.377)	0.675	10
	2000	0.261 (1.007)	0.512** (1.972)		3.601 (1.934)	0.735	12
	2001	-0.0276 (-0.125)	1.107** (5.219)		-0.127 (-0.090)	0.888	14

*. Correlation is significant at the 0.05 level (1-tailed), **. Correlation is significant at the 0.01 level (1-tailed)

Finally Tables 6-8 prove the fourth stylised fact on the economic impacts at the macro-micro levels. That is at both macro and micro levels spending on ICT show positive but inconclusive economic impact. At the macro level, to examine the economic impacts of ICT spending in the Gulf countries we use the data presented in Table 1 above. Our results are summarised in Table 6 above illustrate that the increase in ICT spending in the Gulf countries is positively

and significantly correlated with economic growth (as measured by GDP) but negatively correlated with GDP per capita. The total spending on ICT relative to GDP also shows a positive but statistically insignificant correlation with schooling. Therefore, using ICT spending data illustrated in Tables 1 above the regression results in Table 6 above show inconclusive economic impacts of ICT spending at the macro level in the Gulf countries. We examine the relationship between the total expenditures on ICT, profit and output; Table 8 below illustrates plausible positive⁴ significant correlations between total expenditures on ICT and capital and total output (total sales value) and positive insignificant correlations with profit. These results prove the fourth stylised fact concerning the positive correlation between ICT and input-output indicators at the micro/firm level.

Table 8– Total spending on ICT, labour capital, output and profit across firms 1999-2001

Independent variables		Labour	Capital	ICT spending	Constant	R ²	N
Dependent variables		Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)	Coefficient (t-value)		
All firms (log)							
Total output sales (total value)	1999	-45897.058 (-1.606)	1.207** (5.623)	53.858** (11.852)	8423985.9 (2.570)	0.993	12
	2000	-52249.455 (-1.477)	2.120** (7.150)	-1.473 (-1.615)	7906055.0 (1.891)	0.978	12
	2001	-48147.057* (-1.936)	1.808** (8.189)	13.133* (1.922)	10655725 (3.004)	0.984	11
Profit	1999	-1527.002 (-0.130)	0.140 (0.560)	1.988 (0.496)	129363.28 (0.101)	0.730	11
	2000	-5014.495 (-0.641)	0.310* (1.820)	-0.710 (-0.921)	15621.632 (0.012)	0.652	11
	2001	-11348.674 (-1.236)	0.182 (0.608)	1.561 (0.240)	1888472.6 (1.657)	0.515	10

*.Correlation is significant at the 0.05 level (1-tailed), **. Correlation is significant at the 0.01 level (1-tailed)

Our findings concerning the positive significant correlations between ICT and output and insignificant correlation between ICT and profit imply an inconclusive effect at the micro level.⁵ The macro observations are consistent with the recent literature, indicating the growing but limited effects of ICT diffusion in the developing countries due to a lack of sufficient investment in the complementary infrastructure such as education, skills and technical skills (cf. Pohjola, 2002; Kenny, 2002). Therefore, these results prove the fourth stylised fact in Section 1 above about the inconclusive effect of ICT at the micro level.

⁴ Except in 2000, the correlations between ICT and both output and profit are negative.

⁵ At the aggregate level when using the most recent data (2002) on the share of spending on ICT relative to GDP across four Gulf countries, Bahrain, Saudi Arabia, UAE, and Kuwait, we find an inconclusive effect of ICT, because the share of spending on ICT/GDP shows a significant positive correlation with GDP, but a significant negative correlation with GDP per capita across the four Gulf countries.

4. Conclusions

In this paper we use some primary micro data from the firm survey of Nour (2002b) and some secondary cross countries data to examine four stylised facts on the use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries. We find that at the macro and micro levels the demand for ICT (measured by the use and spending on ICT) is characterised by considerable dynamism over time, i.e. it shows a dynamic increasing trend across countries, but an opposite decreasing trend across firms. At the macro level the use/demand for ICT shows a normal demand curve decreasing in price and increasing in income (measured by GDP per capita). Our results are consistent with the conventional view on the relationship between demand and income, i.e. high population access to Internet, telephone and mobile corresponds to a high GDP per capita. We find that the use of Internet is consistent with the conventional downward sloping demand curve in price, i.e. a fall in the price of Internet service corresponds to greater population access to Internet. Different from the conventional downward sloping demand curve in price, somewhat surprising is that the use of telephone, which shows an upward sloping demand curve in price, i.e. a rise in the price of telephone service is correlated with greater population use of telephone. At the micro level, total spending on ICT increases with firm size (capital and labour) and industry level. At the macro level, the use of Internet and mobile shows positive significant correlations (complementary relationships) with the use of telephone. At the micro level, the use/total spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training. At the micro level, we find positive correlations between the total spending on ICT, output and profit. At the macro level, spending on ICT as percentage to GDP shows a positive significant correlation with GDP - as indicator of economic growth - and a positive insignificant correlation with schooling. Therefore, the total spending on ICT shows positive but somewhat inconclusive economic impacts at both micro and macro levels in the Gulf countries.

References

- Acemoglu, D. (1998), "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality," *Quarterly Journal of Economics*, Vol. 113, No. 4, November (1998): pp. 1055-1089.
- Aghion, P., and Howitt, P. (1998), "Endogenous Growth Theory," MIT Press, Cambridge MA.
- Autor, D. H. , Katz, L. F. and Krueger, A. B. (1998) "Computing Inequality: Have Computers Changed the Labour Market?," *The Quarterly Journal of Economics*, Vol. 113, No. 4, November (1998): pp.1169 – 1213.
- Barro, R. J. and Lee, W. (2000), "International Data on Education Attainment Updates and Implications," NBER Working Paper Series No. 7911.
- Berman, E., Bound J., and. Griliches Z., (1994), "Change in the Demand for Skilled Labour within U.S. Manufacturing Industries: Evidence from the Annual Survey of Manufacturing," *Quarterly Journal of Economics*, Vol. CIX, No.2: pp. 367 –397 (pp.367-398 (Vol.109 May).
- Berman, E. Bound, J. and Machin, S. (1998), "Implications of Skill-Biased Technological Change: International Evidence," *Quarterly Journal of Economics*, Vol. 113, No.4, November 1998: pp. 1245-1279.
- Bresnahan, T. F. Brynjolfsson, E. and Hitt, L. M. (1999), "Information Technology, Workplace Organization, and the Demand for Skilled Labour: Firm- Level Evidence," *NBER Working Paper Series*, No. 7136
- Brynjolfsson, E., and Yang, S. (1996). "Information Technology and Productivity: A review of the literature". *Advances in Computers* 43: 179-214.
- Bound, J. and Johnson G. (1992), "Change in the Structure of Wages in the 1980s: An Evaluation of Alternative Explanations" *American Economic Review* (Vol. LXXXII) Vol. 82 No. 3, (June): pp.371- 392.
- Colecchia, A. and Papaconstantinou, G. (1996), "The Evaluation of Skills in OECD Countries and the Role of Technology, " *STI Working Paper* 1996/6, OECD/GD (96) 183–Paris.
- ESCWA (2003), "Regional Profile of the Information Society in Western Asia," ESCWA, 2003.
- Freeman, C. and Soete, L (1985) "Information Technology and Employment: An Assessment," SPRU Sussex. UK. April 1985.
- Freeman, C. and Soete, L (1994) "Work for all or Mass Unemployment ? Computerised Technical Change into the Twenty-first Century," London, Printer, 1994.
- Freeman, C. and Soete, L, (1997), "The Economic of Industrial Innovation," 3rd Edition, Cassell, London: pp.2, 24, 404-405.
- Garcia Cervero, S. (1997) "Growth Technology, and Inequality: An Industrial Approach," *EUI Working Paper* 97-26.
- Goldin, C and Katz, L, F. (1998), "The Origin of Technology Skill Complementarity," *The Quarterly Journal of Economics*, Vol. 113, No. 3, August (1998): pp. 693 – 732.
- Hitt, L. and Brynjolfsson, E. (1996) "Productivity, business profitability, and consumer surplus: Three different measures of information technology value," *MIS Quarterly* 20:121-42.
- Hwang, Gyu-heui (2000), "Diffusion of Information and Communication Technologies and Changes in Skills," October 2000, *SPRU Electronic Working Paper Series*, No. 48.
- Jorgenson, D. W., Gallop, F. M and Fraumeni, B. M. (1987) "Productivity and US Economic Growth," Cambridge MA., Harvard University Press.
- Machin, S. and Van Reenen, J. (1998), "Technology and Changes in Skill Structure: Evidence from Seven OECD Countries," *Quarterly Journal of Economics*, Vol. 113, No. 4, November (1998): pp. 1215-1244.
- Muysken, J., S. Nour, (2006), "Deficiencies in Education and Poor Prospects for Economic Growth in the Gulf Countries: The Case of the UAE," *The Journal of Development Studies*: Routledge: Taylor and Francis Group Ltd., UK, Vol. 42, No. 6, August 2006, pp. 957-980.
- Nour, S. (2006a), "ICT Opportunities and Challenges for Development in the Arab Region," *Chapter 8 in A. P. D'Costa (ed.) "The New Economy in Development: ICT Challenges and Opportunities" series of Technology, Globalization, and Development*, Vol. 2, Palgrave Macmillan's, September 2006, pp. 161-187.
- Nour, S. (2002a), "ICT opportunities and Challenges for Development in the Arab World," Paper prepared for UNU/WIDER Conference on the New Economy in Development, 10-11 May 2002, UNU-WIDER Discussion Paper Series DP2002/83, Helsinki.
- Nour, S. (2002b), "Firm Survey: Technological Change and Skill Development: A comparative study of Chemical and Metal Medium and Large Scale Enterprises in the UAE," February-April 2002.

- Pohjola, M. (2000) "Information Technology and Economic Growth: A Cross- Country Analysis," *WIDER/UNU Working Paper series*: WP173, January 2000.
- Pohjola, M. (ed.) (2001) "Information Technology, Productivity and Economic Growth: International Evidence and Implications for Economic Growth," Oxford, Oxford University Press April 2001.
- Madar Research Group: www.madarresearch.com
- International Telecommunication Union database (ITU).
- UNDP (2002) "Human Development Report (2002): Deepening Democracy in a fragmental World" UNDP- New York- Oxford, Oxford University Press, July, 2002.
- UNDP (2004) "Human Development Report (2004): Cultural Liberty in Today's Diverse World" UNDP- New York- Oxford, Oxford University Press, July 2004.
- UNESCO, UIS (2005) The UNESCO UIS database 2005, available online at: www.unesco.org World Development Indicators database.
- WITSA (2002) "Digital Planet 2002" (Arlington: The Global Information Economy, The World Information Technology and Services Alliance).

The UNU-MERIT WORKING Paper Series

- 2011-01 *Mitigating 'anticommons' harms to research in science and technology* by Paul A. David
- 2011-02 *Telemedicine and primary health: the virtual doctor project Zambia* by Evans Mupela, Paul Mustard and Huw Jones
- 2011-03 *Russia's emerging multinational companies amidst the global economic crisis* by Sergey Filippov
- 2011-04 *Assessment of Gender Gap in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-05 *Assessment of Effectiveness of China Aid in Financing Development in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-06 *Assessment of the Impacts of Oil: Opportunities and Challenges for Economic Development in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-07 *Labour Market and Unemployment in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-08 *Social impacts of the development of science, technology and innovation indicators* by Fred Gault
- 2011-09 *User innovation and the market* by Fred Gault
- 2011-10 *Absorptive capacity in technological learning in clean development mechanism projects* by Asel Doranova, Ionara Costa and Geert Duysters
- 2011-11 *Microeconomic analysis of rural nonfarm activities in the Kyrgyz Republic: What determines participation and returns?* By Aziz Atamanov and Marrit van den Berg
- 2011-12 *Immigration and growth in an ageing economy* by Joan Muysken and Thomas Ziesemer
- 2011-13 *State-led technological development: A case of China's nanotechnology development* by Can Huang and Yilin Wu
- 2011-14 *A historical perspective on immigration and social protection in the Netherlands* by Melissa Siegel and Chris de Neubourg
- 2011-15 *Promoting return and circular migration of the highly skilled* by Metka Hercog and Melissa Siegel
- 2011-16 *Voluntary agreements and community development as CSR in innovation strategies* by Vivekananda Mukherjee and Shyama V. Ramani
- 2011-17 *Strengthening the roles of political parties in Public Accountability - A case study of a new approach in political party assistance* by Renée Speijcken
- 2011-18 *The elusive quest for the golden standard: Concepts, policies and practices of accountability in development cooperation* by Renée Speijcken
- 2011-19 *Are health care payments in Albania catastrophic? Evidence form ALSMS 2002, 2005 and 2008* by Sonila Tomini and Truman G. Packard
- 2011-20 *On India's plunge into Nanotechnology: What are good ways to catch-up?* By Shyama V. Ramani, Nupur Chowdhury, Roger Coronini and Susan Reid
- 2011-21 *Emerging country MNEs and the role of home countries: separating fact from irrational expectations* by Rajneesh Narula and Quyen T.K. Nguyen
- 2011-22 *Beyond knowledge brokerage: An exploratory study of innovation intermediaries in an evolving smallholder agricultural system in Kenya* by Catherine W. Kilelu, Laurens Klerkx, Cees Leeuwis and Andy Hall
- 2011-23 *Dynamics of biosciences regulation and opportunities for biosciences innovation in Africa: Exploring regulatory policy brokering* by Ann Kingiri and Andy Hall

- 2011-24 *The when and where of research in agricultural innovation trajectories: Evidence and implications from RIU's South Asia projects* by Vamsidhar Reddy, T.S., Andy Hall and Rasheed Sulaiman V.
- 2011-25 *Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help?* By Bronwyn H. Hall and Christian Helmers
- 2011-26 *Technology alliances in emerging economies: Persistence and interrelation in European firms' alliance formation* By Rene Belderbos, Victor Gilsing, Jojo Jacob
- 2011-27 *Innovation pathways and policy challenges at the regional level: smart specialization* By René Wintjes and Hugo Hollanders
- 2011-28 *Innovation and productivity* by Bronwyn H. Hall
- 2011-29 *Mapping the interdisciplinary nature and co-evolutionary patterns in five nano-industrial sectors* by Lili Wang and Ad Notten
- 2011-30 *Assessment of industrial performance and the relationship between skill, technology and input-output indicators in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-31 *Assessment of skill and technology indicators at the macro-micro levels in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-32 *Education, training and skill development policies in Sudan: Macro-micro overview* by Samia Satti Osman Mohamed Nour
- 2011-33 *Estimating the rate of return to education in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-34 *The importance (impact) of knowledge at the macro-micro levels in Sudan* by Samia Satti Osman Mohamed Nour
- 2011-35 *Angus Maddison and Development Economics* by Adam Szirmai
- 2011-36 *Managerial ownership and urban water utilities efficiency in Uganda* by Dorcas Mbuvi and Achraf Tarsim
- 2011-37 *Immigration and growth in an ageing economy* by Joan Muyskens and Thomas Ziesemer
- 2011-38 *The Development of Diaspora Engagement Policies in Burundi and Rwanda* by Sonja Fransen & Melissa Siegel
- 2011-39 *Understanding the changing role of the Turkish diaspora* by Özge Bilgili & Melissa Siegel
- 2011-40 *Understanding Ethiopian diaspora engagement policy* by Katie Kuschminder and Melissa Siegel
- 2011-41 *Engaging the diaspora in India* by Metka Hercog and Melissa Siegel
- 2011-42 *Protecting Vulnerable Families in Central Asia: Poverty, vulnerability and the impact of the economic crisis* by Franziska Gassmann
- 2011-43 *Innovation performance and embeddedness in networks: evidence from the Ethiopian footwear cluster* by Mulu Gebreeyesus and Pierre Mohnen
- 2011-44 *The power of the strong state: A comparative analysis of the diaspora engagement strategies of India and Ethiopia* by Katie Kuschminder and Metka Hercog
- 2011-45 *New insights on the role of location advantages in international innovation* by Rajneesh Narula and Grazia D. Santangelo
- 2011-46 *Preferences for conditioning and being conditioned - experimental & survey evidence from Zambia* by Esther Schüring
- 2011-47 *International migration and local employment: analysis of self-selection and earnings in Tajikistan* by Aziz Atamanov and Marrit van den Berg

- 2011-48 *Complementarity between in-house R&D and technology purchasing: evidence from Chinese manufacturing firms* by Jun Hou and Pierre Mohnen
- 2011-49 *The internationalization of R&D* by Bronwyn H. Hall
- 2011-50 *Missing the target: Lessons from enabling innovation in South Asia* by Sulaiman V. Rasheed , Andy Hall and T.S. Vamsidhar Reddy
- 2011-51 *Optimal public investment, growth, and consumption: Evidence from African countries* by Augustin Kwasi Fosu, Yoseph Yilma Getachew and Thomas Ziesemer
- 2011-52 *Size, competition, and innovative activities: a developing world perspective* by Abdul Waheed
- 2011-53 *What Changes Gini Coefficients of Education? On the dynamic interaction between education, its distribution and growth* by Thomas Ziesemer
- 2011-54 *Global Framework for differential pricing of pharmaceuticals* by Rutger Daems and Shyama V. Ramani
- 2011-55 *The effect of net immigration on economic growth in an ageing economy: transitory and permanent shocks* by Joan Muysken and Thomas Ziesemer
- 2011-56 *Research, higher education and innovation: redesigning multi-level governance within Europe in a period of crisis* by Jo Ritzen and Luc Soete
- 2011-57 *A renaissance for social mobility and its significance for the bridge towards postsecondary education* by Jo Ritzen
- 2011-58 *Arab Regional Systems of Innovation: Characteristics and Implications* by Samia Satti Osman Mohamed Nour
- 2011-59 *The use and economic impacts of ICT at the macro-micro levels in the Arab Gulf countries* by Samia Satti Osman Mohamed Nour